



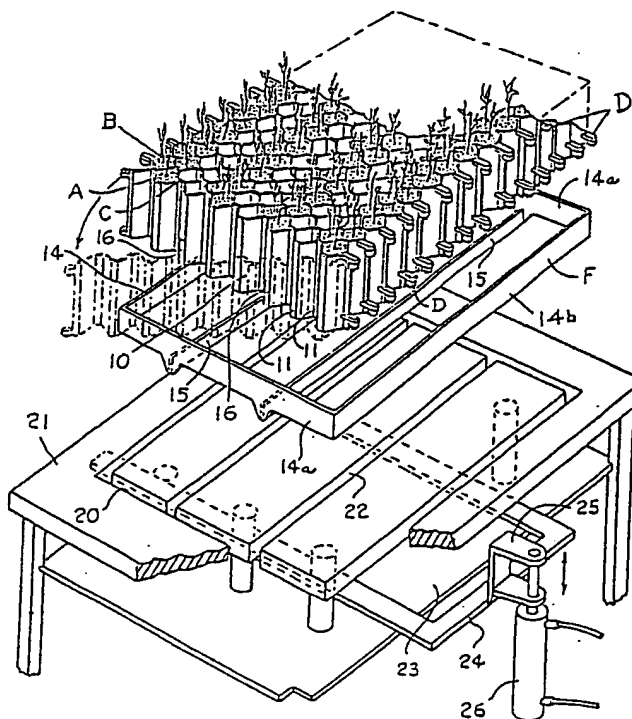
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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## (54) Title: METHOD AND APPARATUS FOR PROPAGATING PLANTS

## (57) Abstract

A method and apparatus for propagating plants wherein provision is made for aeration and drainage of the root plug with increased air flow to the upper or leafy parts of the plants extending across a growing tray in a predetermined pattern. Provision is also made for filling the compartments (A) of a growing tray with growing medium in a predetermined pattern to permit air flow across the tray from the bottom. Provision is also made to support strips (10, 11) forming a growing tray permitting horizontal movement of the strips as well as rows of compartments (A) containing the plants, and a shelf (18) is provided in the strips or partitions (10, 11) of the trays extending for a limited distance over a minor area of the compartments (A) to confine the growing medium within the trays while permitting insertion of a member (26a) for pushing the plant upwardly from the bottom out of the respective growing containers (A).



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## METHOD AND APPARATUS FOR PROPAGATING PLANTS

Technical Field

This invention relates to seedlings and other small plants, seedling trays and method of propagation of plants.

In the propagation of seedlings and other growing plants, efforts have been made to provide strips which, when utilized with other similar strips in pairs, form trays having rows of compartments for accommodating the root plug or root ball of a growing plant prior to transplanting same for further growth.

Background Art

Such strips are illustrated in U. S. Patent Numbers 4,050,188 and 4,453,344. U. S. Patent Number 3,515,036 illustrates a growing container or tray wherein respective rows of compartments are hinged at each end. French Patent Number 1,307,886 of 1962 illustrates the use of hinges in connection with rows of compartments formed into a tray or block. U. S. Patent Number 4,006,558 illustrates the use of a two piece corrugated container having an inwardly tapering lower portion for confining growing material through a wedging action.

Disclosure of Invention

The apparatus and methods contemplated herein make provision for growing a plant having an aerated root ball or plug utilizing a vertical slot opening. Provision is made for surrounding the individual growing compartments with an opening or openings to provide for air pruning of the root systems as well as air flow to the bottoms of the leafy portion of the plants while making possible aeration of the root system.

Accordingly, it is an important object of the present invention to provide for aeration and drainage of the root systems of seedlings and other small plants through the use of compartments having vertical openings therein, and surrounding such respective compartments with additional openings providing air

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pruning of the root systems at the vertical openings as well as air to the leafy top portions of the plants.

Another important object of the present invention relates to horizontal movement of strips illustrated in the form of generally sinuous barriers which form rows of growing compartments so as to move the plants away from adjacent plants of the growing trays to avoid damage especially to the tops of the plants during their removal from the tray preparatory to transplanting. It is advantageous to hinge the ends of each of the pairs of strips forming growing compartments as such hinges facilitate such horizontal movement one at a time manually with support of the strips or in pairs especially if a machine is to be utilized to remove the young plants for transplanting. The strips may advantageously not be hinged but may be removed horizontally in pairs one row at a time while supported for subsequent pushing up of the plants from the bottom of the compartments while lifting same from the top as may be carried out by a machine or partially manually as illustrated.

Another object of the invention is the provision of apparatus for facilitating the filling of a tray with a growing medium. This is preferably accomplished utilizing a template or other form of barrier having an opening therein limiting entrance of the growing material to those compartments or areas of the trays where such is desired.

The injected molded plastic strips as well as a tray formed from integrally connected strips as illustrated contemplate the use of shelves or inwardly tapering wedge portions formed at an acute angle extending inwardly over a minor portion of the area of the growing compartments at the bottom in order to retain the growing medium within the growing compartments.

A table is provided having openings therein permitting raising and lowering of a frame for confining the individual strips which comprise the hinged or unhinged embodiments of the invention is illustrated. The frames which support and contain the strips of the hinged and unhinged versions may be lowered within the openings of the table leaving the plants contained within the block or strips on the table for easy separation of the strips for removing the plants from the strips one row at a time.

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An integral tray is provided with a groove or labyrinth between respective compartments and adjacent openings for aeration and drainage and which permits upward flow of air about the respective compartments.

Another object of the invention is the provision of strips forming rows of compartments which may be formed into a tray such that each compartment is substantially surrounded by air with the compartments occupying the greater area of the tray conserving space while accomplishing the objects of the invention.

It has been found that aeration of the root ball or root system of seedlings and other young plants may be accomplished by providing growth compartments with a vertical opening permitting air flow while excluding light to the extent that root growth is facilitated and whereby air pruning may be provided as a result of exposure to air in the absence of substantial moisture when the roots attempt to grow beyond the confines of the vertical opening. The vertical slot provides for the escape of excess moisture via drawing into an empty chamber and via evaporation due to air flow in the adjacent empty chamber along the adjacent contact surfaces between strips during watering of the plant assuring proper moisture while preventing impoundment of water as would damage the root systems. Resulting root systems grow predominantly downward and outwardly throughout the growing medium being air pruned without the usual problem of root ringing.

The micro-environment of each of the plants is further enhanced through the provision for air flow upwardly from the bottom of the trays containing growth compartments or otherwise across the trays and the lower foliage or leafy top portions of the plant providing supplemental carbon dioxide or carbon dioxide from the air flow to prevent leaf yellowing and to facilitate growth. Also, provision of air flow increases plant hardening or acclimation to an outdoor environment after transplanting; provides less favorable climate for plant pathogen growth; and provides for overall less stress on the plant so there are fewer potential disease infection points present. The provision of the aforesaid micro-environment is facilitated through the use of opposed pairs of elongated molded plastic

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strips which form rows of growing compartments for the plants as trays or blocks. The resulting plants are exceptionally healthy and advanced in growth and are characterized by flat laterally extending root systems as illustrated in the drawings. The laterally extending root systems have a vertical planer orientation with the individual roots extending somewhat randomly outwardly and downwardly, having been formed as in the contact spaces between strips or otherwise in such vertical slots as formed thereby in the presence of air and moisture but without growth medium.

The trays may be filled with a growing medium utilizing a template having patterned openings therein for receiving a growing medium into predetermined compartments while excluding growing medium from the openings which surround the growing compartments. A shelf or ledge extends inwardly for a limited distance of approximately 1/16 to 1/8 of an inch across the lower portion of each of the growing compartments to help confine growing medium forming plugs or root balls for the plants. The open bottom is almost as wide as the opening at the tops of the compartments providing a large evaporative surface. As described above the adjacent strips forming respective rows of growing compartments may be hinged at their ends or they may be otherwise joined or accommodated within an injection molded plastic frame which provides spaced vertical supports at the bottom while encompassing the strips to confine them in blocks or trays.

The strips may be of such construction that interior compartments are formed between the respective growing compartments of lesser dimension so as to provide for the desirable air flow and aeration of root balls while minimizing lost area for plant growth. The connecting portions of the strips between the compartments may form a rectangular section or opening which bears against flat portions forming the compartments of adjoining strips as illustrated.

The constructions described above may be formed into integral molded trays wherein the ends of the strips are connected as well as transverse strips provided for utilizing vertical grooves forming labyrinths for aeration of the root ball

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while providing air flow entirely about the respective compartments.

#### Brief Description of the Drawings

The construction designed to carry out the invention will be hereinafter described, together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown and wherein:

Figure 1 is a perspective view illustrating the use of a template having patterned openings therein to limit entry of growing medium into predetermined patterns of compartments,

Figure 2 is an enlarged sectional elevation taken on the line 2-2 in Figure 1,

Figure 3 is a perspective view illustrating a frame for confining and supporting interconnected strips utilized in pairs to form rows of growing compartments together with apparatus including a table facilitating removal of the plants from the trays,

Figure 4 is a plan view further illustrating an alternate form of strips forming the trays with latches for interconnecting the strips forming compartments,

Figure 5 illustrates removal of rows of plants in series wherein a single row is dislodged from the bottom through insertion of spaced upwardly projecting members,

Figure 5-A is a perspective view similar to Figure 5 illustrating removal of the plants from the growing compartments,

Figure 6 is a plan view illustrating an alternate form of hinged rows of strips or sinuous barriers with sequential horizontal movement of pairs of strips while supporting them by hinges,

Figure 7 is a perspective view further illustrating the opposed strips of Figure 6 forming hinged rows of growing compartments,

Figure 8 illustrates another alternate form of the invention wherein an integral tray provides air flow about the

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growing compartments with aeration and drainage of the root balls,

Figure 9 further illustrates the inwardly extending shelves or ledges at the bottom of the various compartments extending inwardly for a limited distance to form and contain the root balls,

Figure 10 is a perspective view illustrating dislodgement of the plants of integral trays by upward projections extending from the bottom into the growing compartments,

Figure 11 is a perspective view of a plant of the present invention,

Figure 12 is a sectional plan view taken on the line 12-12 in Figure 11, and

Figure 12-A is a sectional plan view illustrating an alternate form of root ball.

#### Best Mode For Carrying Out The Invention

The drawings illustrate a growing tray constructed of molded plastic components for propagating plants having upper portions and root systems in a growing medium having a plurality of rows of growing compartments A for containing a growing medium. The compartments are spaced across the growing tray in a predetermined pattern. A plurality of rows of openings B in the tray are located between the growing compartments defining the predetermined pattern of the compartments. The openings are, therefore, also spaced across the growing tray in a predetermined pattern. Thus, the growing tray may be supported in elevated position to accommodate air flow from beneath the growing tray upwardly through the openings facilitating growth of the upper portions of the plants. Elongated upright openings C are disposed in the growing compartments providing oxygen to the growing medium and the root systems contained therein. Hinges D may be provided at the ends of the rows of growing compartments permitting limited horizontal movement as well as support for the rows of plants. A template having an opening E affords access to growing medium for filling growing compartments in a predetermined pattern for surrounding each compartment with a flow of air. A frame F contains strips in a block or tray and supports the strips from the bottom.



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Figures 1 through 3 illustrate the use of opposed strips in hinged pairs of strips forming trays best suited to manual operation.

The configuration of the strips of Figures 1 through 3 is similar to that of U. S. Patent Number 4,453,344 wherein openings surround each of the growing compartments being formed from vacant compartments or volumes to permit the flow of air upwardly around the plants while permitting aeration of the root ball with air pruning. The strips are preferably injection molded of plastic and are somewhat flexible being of flat thin walls of generally uniform thickness. However, use of the strips in opposed pairs permits reinforcement against excessive bending when assembled into a growing tray. It will be observed that no plant is bordered by an opening wherein roots may interengage with roots of an adjacent root ball. Each of the strips are generally sinuous barriers having diverging portions 10 together with interconnecting or bridging walls 11 which form flat surfaces and together with opposed flat surfaces of a next adjacent strip form vertical slots which are so narrow as to substantially exclude light while permitting the removal of excess moisture as well as the entrance of air for aerating the root ball. The adjacent strips are preferably interconnected and maintained in alignment by interlocking pegs or projections 12 and slots 13 which aid in fastening the strips together into trays.

The injection molded plastic frames F encompass the block of strips forming rows of growing compartments for the plants through the use of a surrounding frame bordering members 14 having end frame members 14a which are bridged side frame members 14b encompassing a plurality of strips forming rows of growing compartments extending about and confining the strips. Intermediate horizontally spaced support members in the form of longitudinal vertically disposed ribs 15 integral with the bordering member extend into the vertical slots 16 forming the lower portions of the strips to provide vertical support from the bottom for the respective strips contained within the frame. No such vertical slots 16 are desirable where the strips are of minimal height since it is convenient to support short strips directly on the tops of the intermediate ribs 15. The support

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members are spaced below the bordering members to permit the strips to be confined and supported from the bottom.

Figures 1 and 2 illustrate the use of a template which has openings in a planer upper surface at E which form patterns permitting entry of growth medium or suitable growing material into predetermined compartments defined between the respective pairs of strips. A border or frame member 17 provides means for assuring registry of openings E within the upper surface of the template with the proper predetermined compartments.

During such filling of the tray with growth medium, the tray is placed on a flat surface, and any excess of growth medium screeded off or otherwise removed. A concave upper surface is placed in the respective filled compartments and the medium compressed by utilizing the usual convex compression means forming a plug or compressed unit of growing medium for containing roots of the plants. The template may be flexible or take the form of any suitable barrier means.

It will be noted in Figure 2 that in each of the vertical inner surfaces of the strips defining growing compartments, a shelf or ledge 18 extends inwardly over a minor portion of the cross section of the compartment. Considerably less than one-half of the bottom of the growing compartments is covered by the shelves. The shelves or ledges extend outwardly at an acute angle integrally from a lower edge of the walls of the growth compartments forming with the bottoms of the strips a lower planer surface for supporting the growth medium plug. Such shelf or ledge structure sufficiently support from the bottom the growing medium within the respective growing compartments to form root plugs or root balls for the plants. The plugs would have to be sheared away to come through the bottom of the tray. The upper surfaces 18a of the shelves taper inwardly and downwardly at an acute angle to the lower planer surface of the tray.

Figure 3 illustrates a table wherein an opening slot 20 in the table top 21 forms a border coextensive with the perimeter or bordering member of the trays F while the longitudinal slots 22 permit the tray to be lowered beneath the table upon an intermediate support tray 23 which may be raised or lowered through the support 24 carried by the vertical bracket 25

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upon an extensible portion of a fluid operated cylinder 26 for raising and lowering the platform supporting tray 23. When the frame F is lowered, the tray formed by the respective strips is retained upon the table top. The plants may also be removed manually by pivoting the strips one at a time as illustrated in broken lines in Figure 3 so as to open the respective compartments. Hinges D are carried at each end of the strips.

Figures 4-7 illustrate modified forms of the invention especially adapted to mechanized usage in machines for mechanically removing the plants from the compartments.

Figures 4 and 5 illustrate a modified form of strips in the form of sinuous barriers which in opposed pairs form the growing compartments. The growing compartments A are separated by interconnecting or bridging walls which form rectangular openings or empty compartments B, and at the same time form the vertical slots C which permit aeration of the root ball. Each of the strips include diverging side members 26 and interconnecting or bridging wall members 27 therebetween. Alternate interconnecting wall members are provided as at 27a in the form of connecting members forming the openings B which together with the adjacent vertical surfaces of the strips form the vertical slots or contact portions C of the strips.

Figure 5 illustrates the use of windows 27a in the interconnecting members 27 for saving plastic and for supplying more air to the vertical slot C. Such windows may be used in the strips of Figures 6 and 7.

The strips are joined together in pairs by latches formed by a vertical projection 28 over which a latching portion 29 passes for securement of the strips in pairs to form rows of compartments as illustrated in Figure 5.

Figures 5 and 5-A illustrate the horizontal movement of a row of plants contained in compartments defined between a pair of opposed strips. The plants are removed by simultaneous pushing from the bottom by the upwardly projecting members 26 with pulling up from the top as by the use of fingers shown in broken lines in Figure 5. This action is conveniently adapted to machine operation. The rows of plants may be removed in series in individual rows as illustrated in Figure 5 and removed through insertion of spaced upwardly projecting members 26a.

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Figures 6 and 7 illustrate the use of modified strips similar to those of Figures 4 and 5 wherein hinges are provided at each end. The hinges are provided through the use of vertical spaced lug portions 30 carried by a marginal diverging wall 26b which carry integral portions 31 which are received within links 32 carried by a diverging wall 26b of an adjacent row formed by opposed strips. A hook portion 33 is carried by the lengths 32 and extend over a vertical catch bar 34 integral with the adjacent row. The use of pegs 12 and slots 13 for receiving the pegs is further illustrated in Figures 6 and 7. The pegs serve as means for aligning the strips and aid in holding the strips together to form a tray. Such pegs and slots may be utilized in each of the strips illustrated herein.

In lieu of hinges, the pairs of strips may be integrally connected at each end and because of the limited flexibility afforded by the flat plastic construction, the pairs of strips may simply be flexed open to release the root balls.

Figures 8, 9 and 10 illustrate an integral growing tray or block.

A bordering strip 35 contains an integrally connected strip extending from frame members 35 as at 36. Alternate openings are formed by strips or bars 37 and a dividing bar or strip 38 contains the vertical slot C as a substantially Z-shaped labyrinth having legs 39 joined with an interconnected vertical slot 40. The vertical slot defined by the labyrinth may simply be provided in the form of a connecting slot extending across the partitions or strips 38.

Figure 9 further illustrates the use of the shelf members 18 which border the lower edge of each of the growing containers and extend or taper outwardly at an acute angle with the base of the tray.

Figure 10 illustrates the use of upwardly projecting members 41 which extend entirely across a positioning frame 42. Through this expedient the entire block of plants may be removed at one time from the unitary tray.

Figures 11, 12 and 12-A illustrate plants of the present invention grown utilizing the apparatus and method hereof.

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It will be observed in Figures 11 and 12 that the plant has a pair of generally flat root systems 31a extending outwardly from opposed sides of the root plugs in a vertical plane. The systems are illustrated as extending in diametrically opposed relation. The generally flat root systems are grown between closed adjacent flat surfaces such as at C of strips forming growth compartments such as illustrated. It will be observed root systems extend generally throughout and generally downwardly within the growth material as illustrated at 32a in Figures 11 and 12. In Figure 12-A the generally flat root systems are illustrated at 31b, having been grown in an integral tray as illustrated in Figures 8-10. The laterally extending root systems 31b appear in opposed relation extending outwardly from the root system contained within the growth medium, having been formed in the openings 39 of the tray.

While a preferred embodiment of the invention has been described using specific terms, such description is for illustrative purposes only, and it is to be understood that changes and variations may be made without departing from the spirit or scope of the following claims.

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CLAIMS

1. Apparatus for filling a planting tray having successive rows of growing compartments with growing medium comprising:

a template for receiving growing medium having a pattern therein defining openings permitting the passage of growing medium therethrough to predetermined growing compartments in successive rows while limiting the passage of growing medium except to said predetermined growing compartments; and

means positioning said template wherein said openings therein are in registry with said predetermined growing compartments.

2. The structure set forth in claim 1 wherein said openings are arranged in a pattern wherein said predetermined growing compartments are such that openings are arranged thereabout.

3. The method of filling a planting tray having successive rows of growing compartments with empty openings thereabout with growing medium including the steps of:

placing a barrier means across the top of said planting tray;

providing openings in said barrier means for receiving growing medium for passage into said successive rows of growing compartments;

placing growing medium on said barrier means permitting same to enter said growing compartments while excluding same from said empty openings; and

removing excess growing medium from said barrier.

4. A block of interconnected spaced compartments for propagating plants having tops and root balls including a plurality of opposed strips constructed of generally flat material forming respective rows of spaced compartments comprising;

a plurality of spaced channels for forming with corresponding channels of an opposed strip a row of compartments;

a plurality of spaced connecting members joining adjacent channels in each strip;

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said connecting members each defining an open space therein as well as a flat surface carried at each end thereof in opposed relation to a flat surface in an opposed strip; and

said connecting members each further extending into engagement with a strip of a next row of compartments for spacing said strips;

whereby each compartment is surrounded by air and has at least one air space between respective opposed flat surfaces.

5. The structure set forth in claim 4 including a hinge at the ends of respective rows of compartments for horizontal movement and support of successive rows of compartments in series.

6. The structure set forth in claim 4 wherein said connecting members form substantially rectangular openings which are smaller than said compartments.

7. A growing tray constructed of molded plastic components for propagating plants having upper portions and root systems in a growing medium comprising:

a plurality of rows of growing compartments for containing a growing medium;

said compartments being spaced across said growing tray in a predetermined pattern;

a plurality of rows of openings in said tray between said compartments; and

said openings being spaced across said growing tray in a predetermined pattern;

whereby said growing tray may be supported in elevated position to accommodate air flow from beneath the growing tray upwardly through said openings facilitating growth of the upper portions of the plants.

8. The structure set forth in claim 7 including elongated upright slots in said growing compartments providing oxygen to said growing medium and the root systems contained therein, and means excluding direct light from said root systems.

9. The structure set forth in claim 7 wherein said openings are formed in compartments spaced entirely about said

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growing compartments providing a ring of upwardly flowing air about said growing compartments and the plants carried therein.

10. The structure set forth in claim 8 wherein said plastic components are integrally molded and include a bordering strip, and a dividing strip bordering said growing compartments containing said upright slots.

11. The method of propagating plants having upper portions and root systems in a growing medium comprising the steps of:

growing said plants in a tray having spaced compartments arranged in rows between opposed plastic strips;

moving said plants horizontally in rows in said compartments by moving respective opposed strips in pairs;

supporting said plants in said compartments in said rows after moving said respective strips horizontally; and

then removing said root systems of said plants from said compartments;

whereby the plants are separated in said compartments to avoid injury to upper portions of said plants and facilitating removal of the root systems of the plants.

12. The method set forth in claim 10 wherein said root systems are removed from said compartments by pushing said root systems and the associated growing medium upwardly.

13. A growing tray for propagating plants having upper portions and a root ball formed of a root system in a growing medium comprising:

an elongated row of growing compartments formed by opposed strips having opposed spaced troughs therein; and

a hinge carried on each end of each of said rows of growing compartments.

whereby said strips may be removed successively horizontally while supporting said plants.

14. For use in a tray for propagating seedlings and the like utilizing a plurality of elongated strips which form a plurality of rows of growing compartments, a molded plastic frame comprising:

a bordering member encompassing a plurality of strips forming rows of growing compartments extending about and confining said strips therewithin;



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horizontally spaced support members extending across said bordering members and having connection therewith; and

said support members being vertically spaced below said bordering member to permit the strips to be placed thereacross to support the strips from the bottom while the strips are confined at their ends within said bordering member.

15. The structure set forth in claim 14 including spaced vertical slots within a lower portion of each of said strips for reception of respective support members.

16. The structure set forth in claim 14 including a table top having slotted openings therein accommodating said bordering member and said support members permitting said tray to be lowered therethrough beneath said table top.

17. A growing tray having a plurality of partitions, each formed of stiff plastic bridging material comprising:

a plurality of rows of growing compartments each suitable for growing a single plant;

an inwardly extending ledge integral with said partitions having a free lower edge in a lower portion of said partitions extending across a minor portion of a bottom of said compartments; and

said inwardly extending ledges forming plugs wherein growing material is confined in said growing compartments.

18. A plant having a root plug comprising:

a growing material shaped generally according to the contours of a compartment in a growing tray;

a root system extending generally uniformly throughout and generally downwardly within the growing material; and

a generally flat root system extending outwardly and downwardly from a side of said root plug extending substantially from top to bottom thereof.

19. The plant set forth in claim 17 wherein a pair of said generally flat root systems extend outwardly from opposed sides of said root plug.

20. The method of propagating plants having tops and root balls comprising the steps of:

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growing said plants in a tray including aligned rows of spaced compartments, for containing the respective root balls;

providing an open space surrounding each of said separate spaced compartments in each row affording air flow to the tops of said plants; and

providing a vertical opening in said compartments extending into an adjacent open space permitting drainage of excess moisture and root growth with aeration of the root ball whereby injury to the plants during removal from the compartments of said one row is avoided preparatory to movement of said next row of separate spaced compartments.

21. A growing tray constructed of integrally molded plastic components for propagating plants having upper portions and root systems in a growing medium comprising;

a plurality of rows of growing compartments for containing a growing medium;

said compartments being spaced across said growing tray in a predetermined pattern;

a plurality of rows of openings in said tray between said compartments;

said openings being spaced across said growing tray in a predetermined pattern;

said compartments being integrally joined to form said tray; and

an upright slot in said compartments joining said openings;

whereby said growing tray may be supported in elevated position to accommodate air flow from beneath the growing tray upwardly through said openings facilitating growth of the upper portions of the plants.

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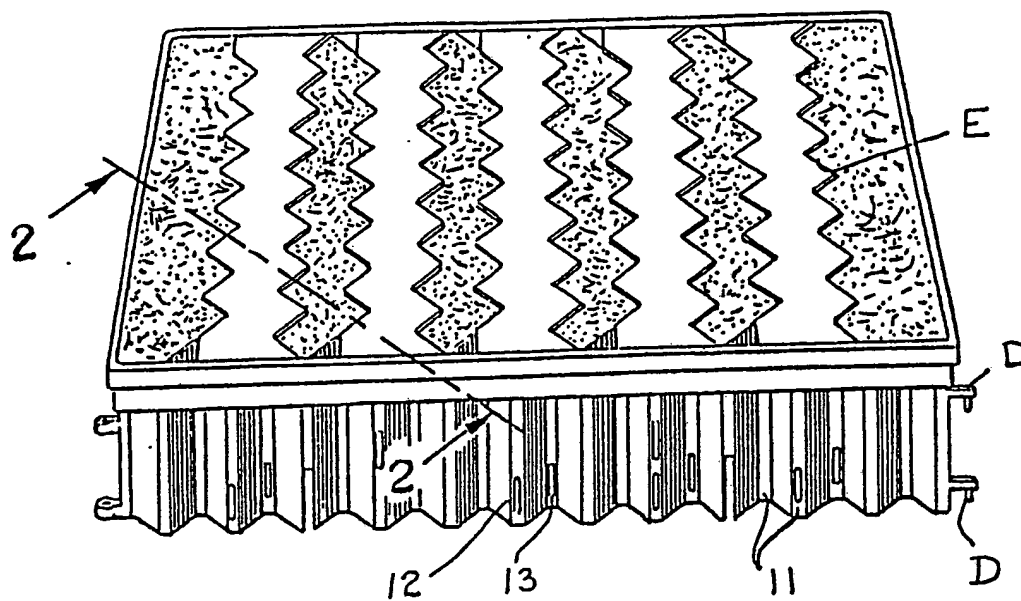


FIG. 1

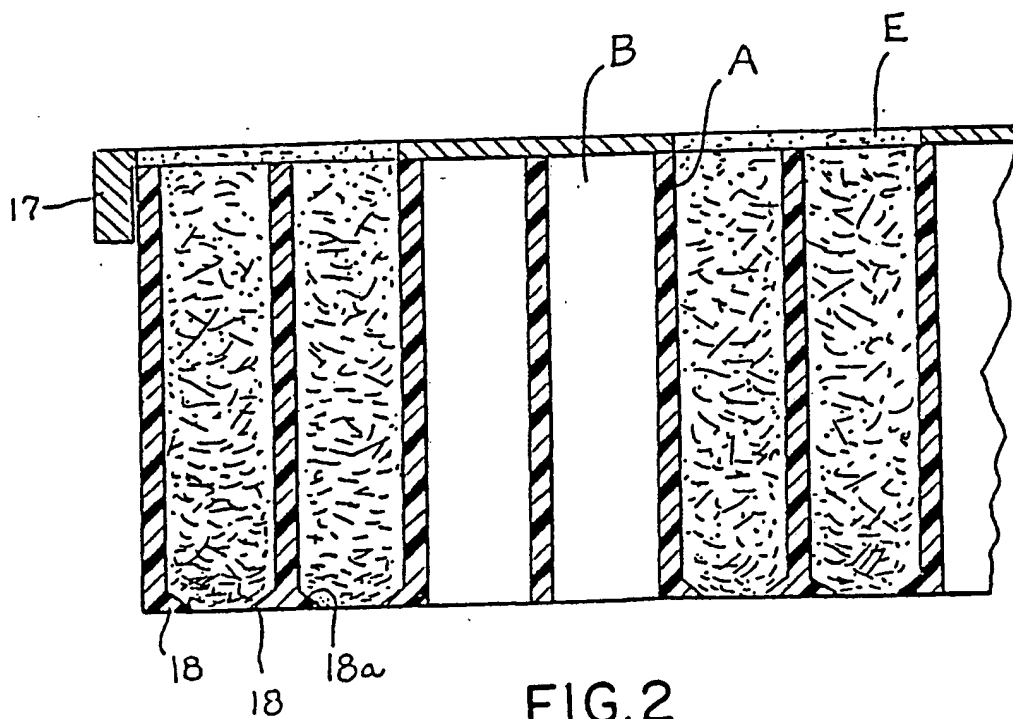
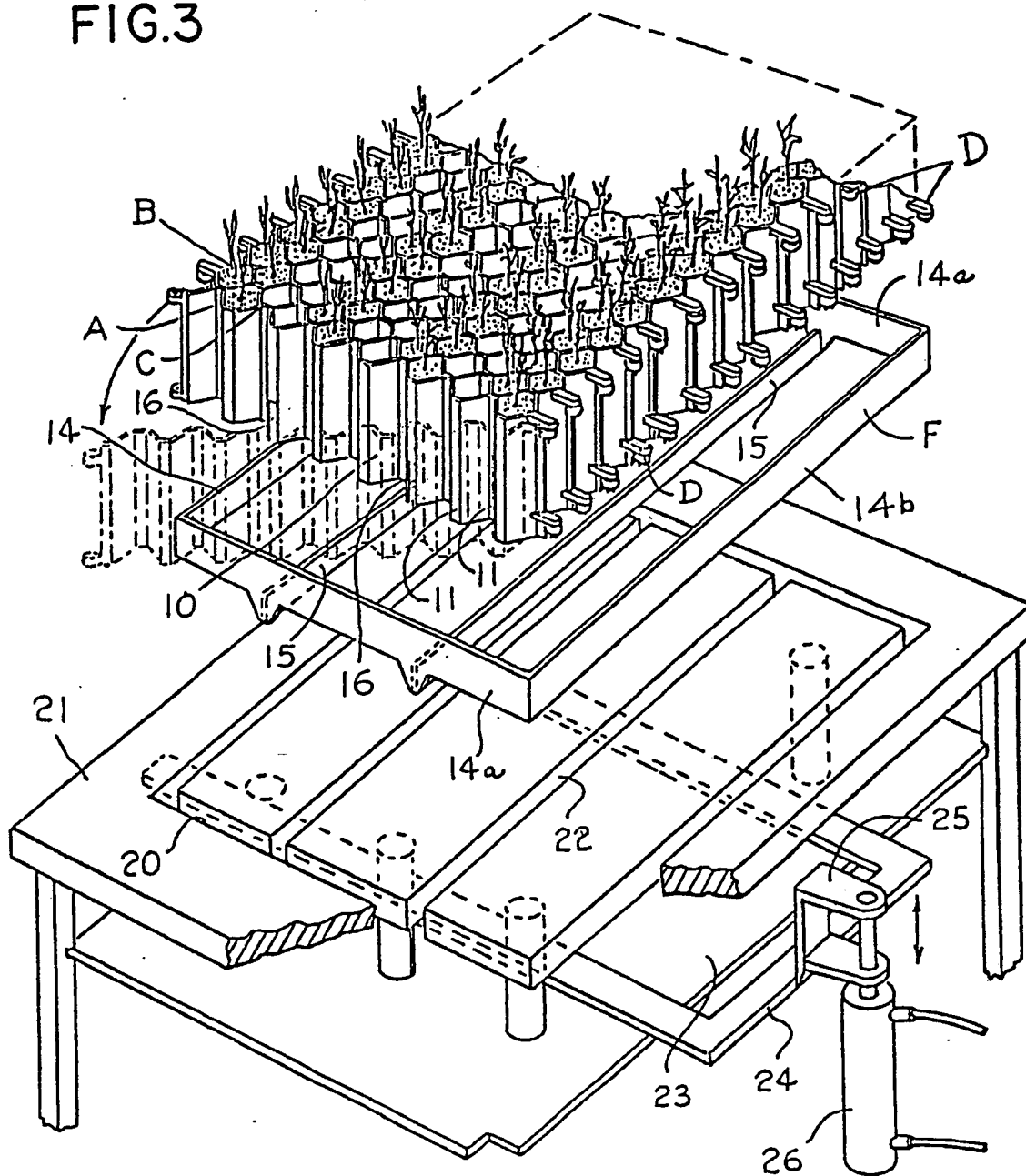


FIG. 2

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FIG.3



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FIG. 4

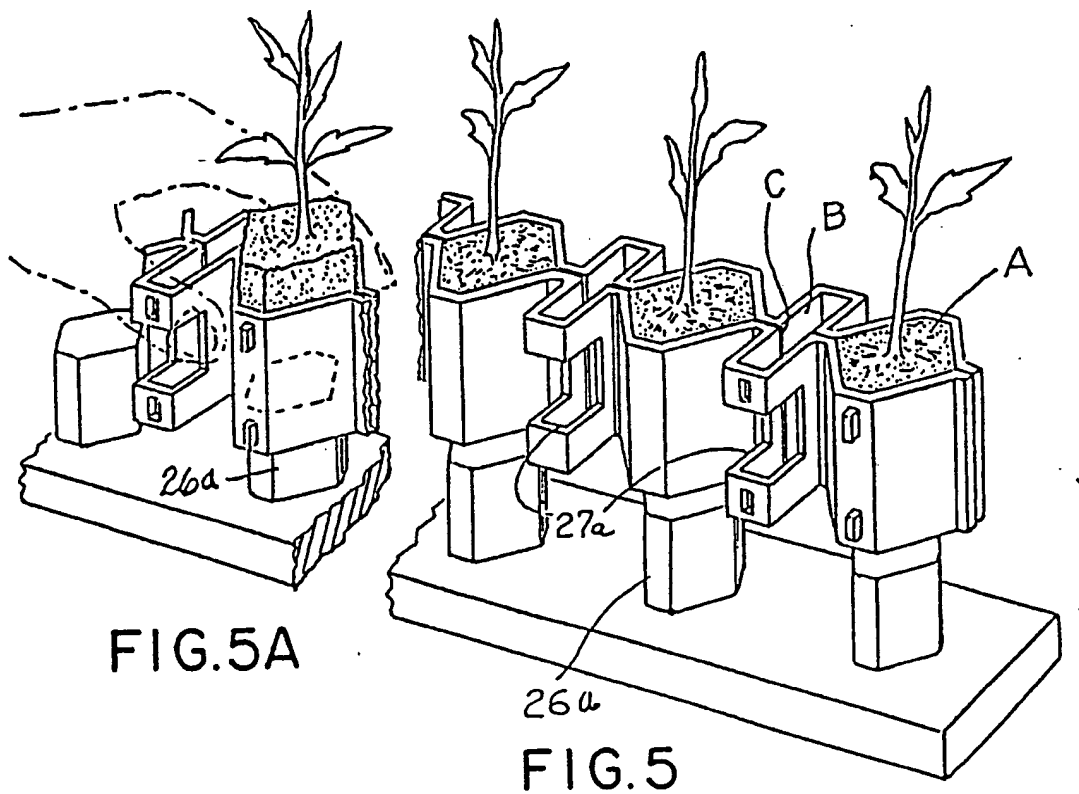
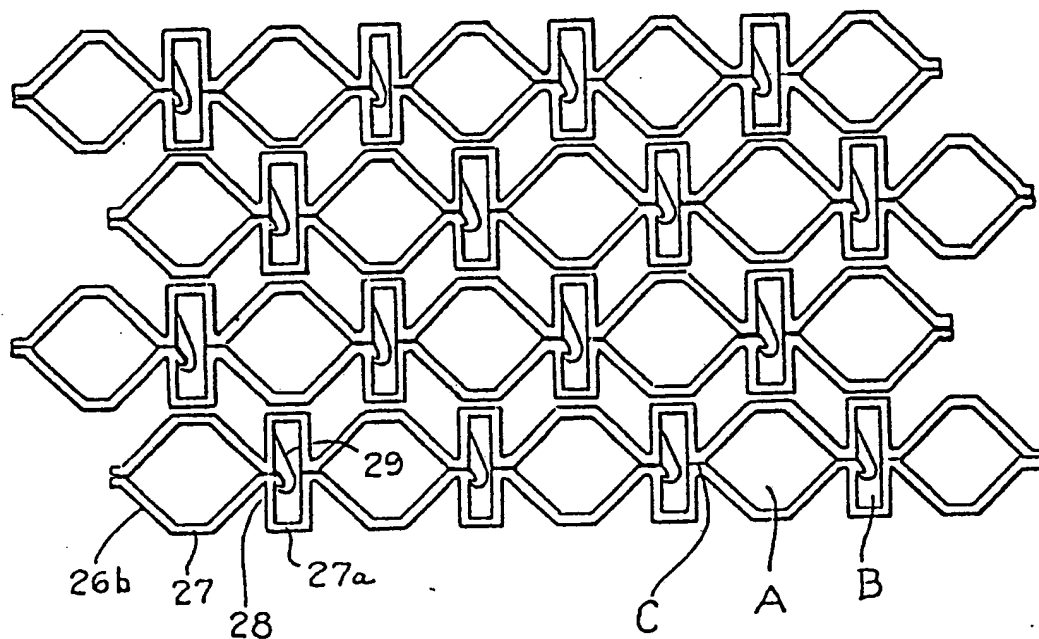


FIG. 5A

FIG. 5

FIG.6

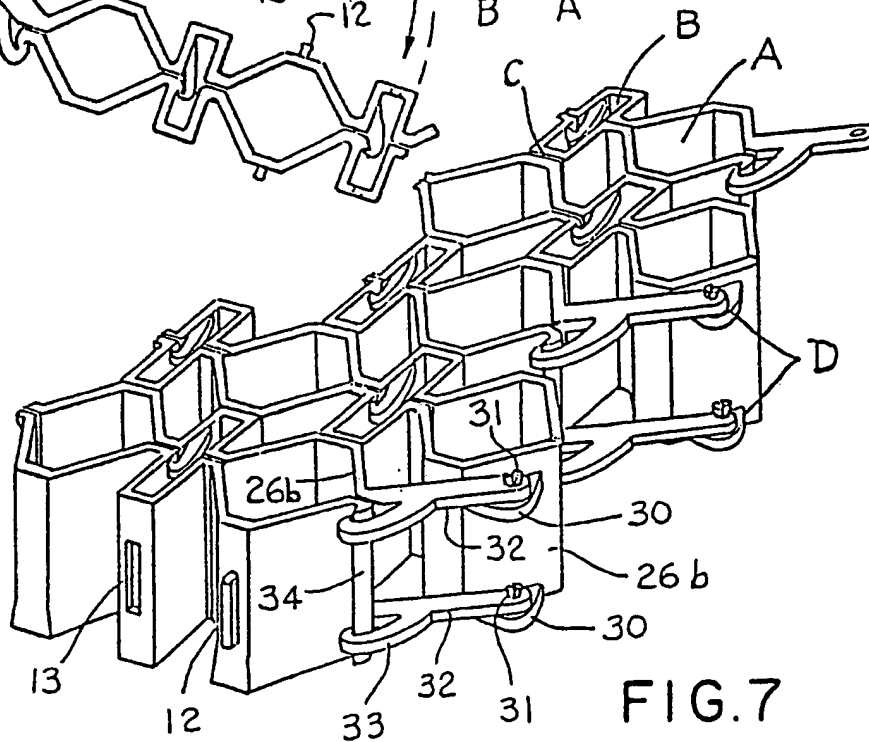
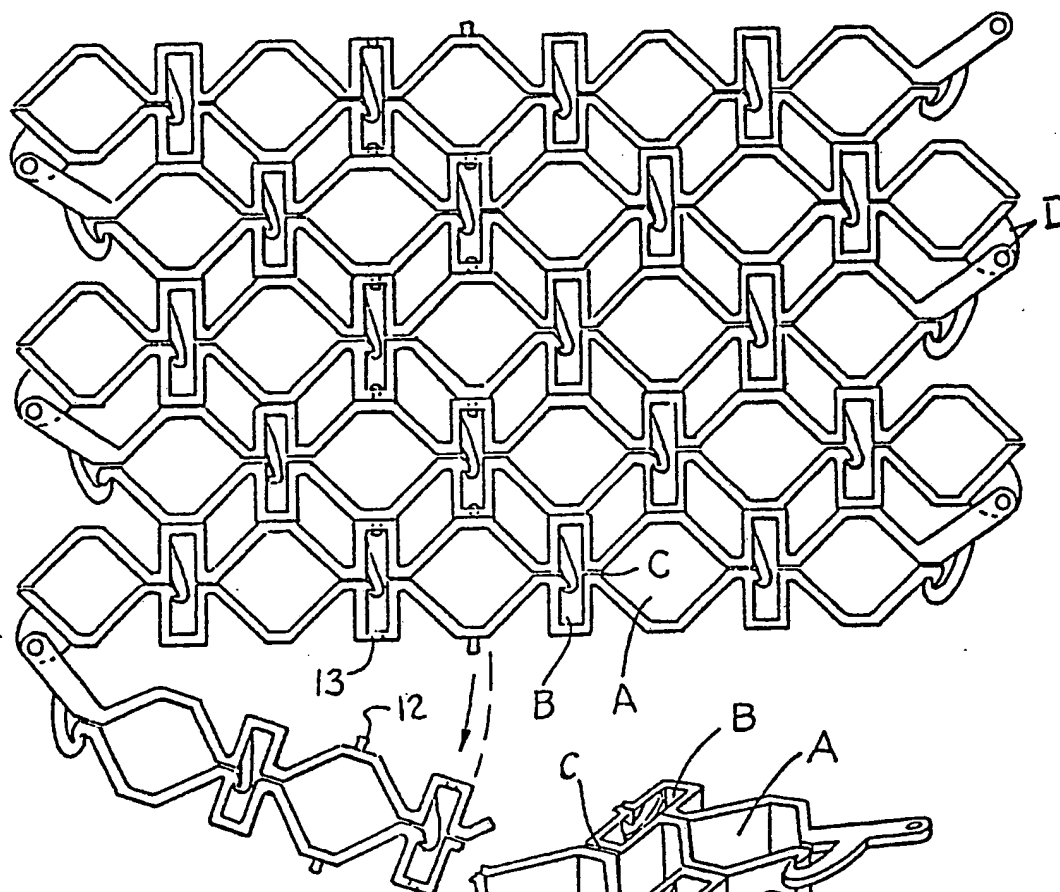
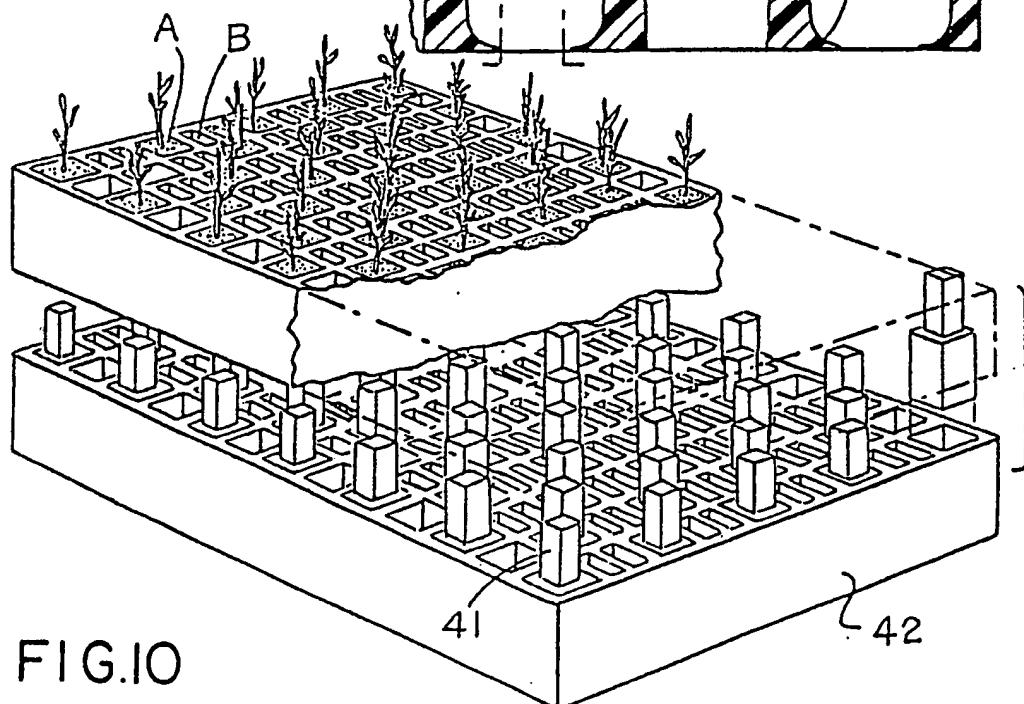
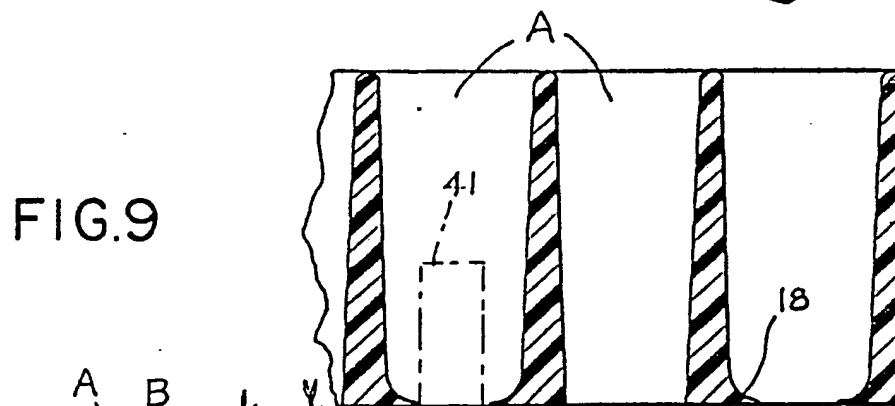
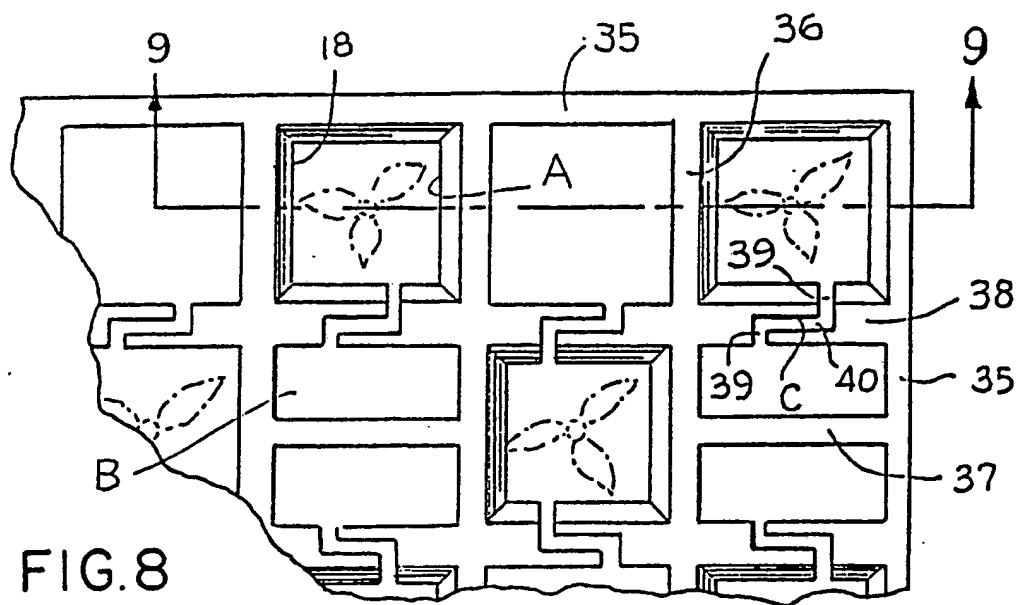


FIG.7



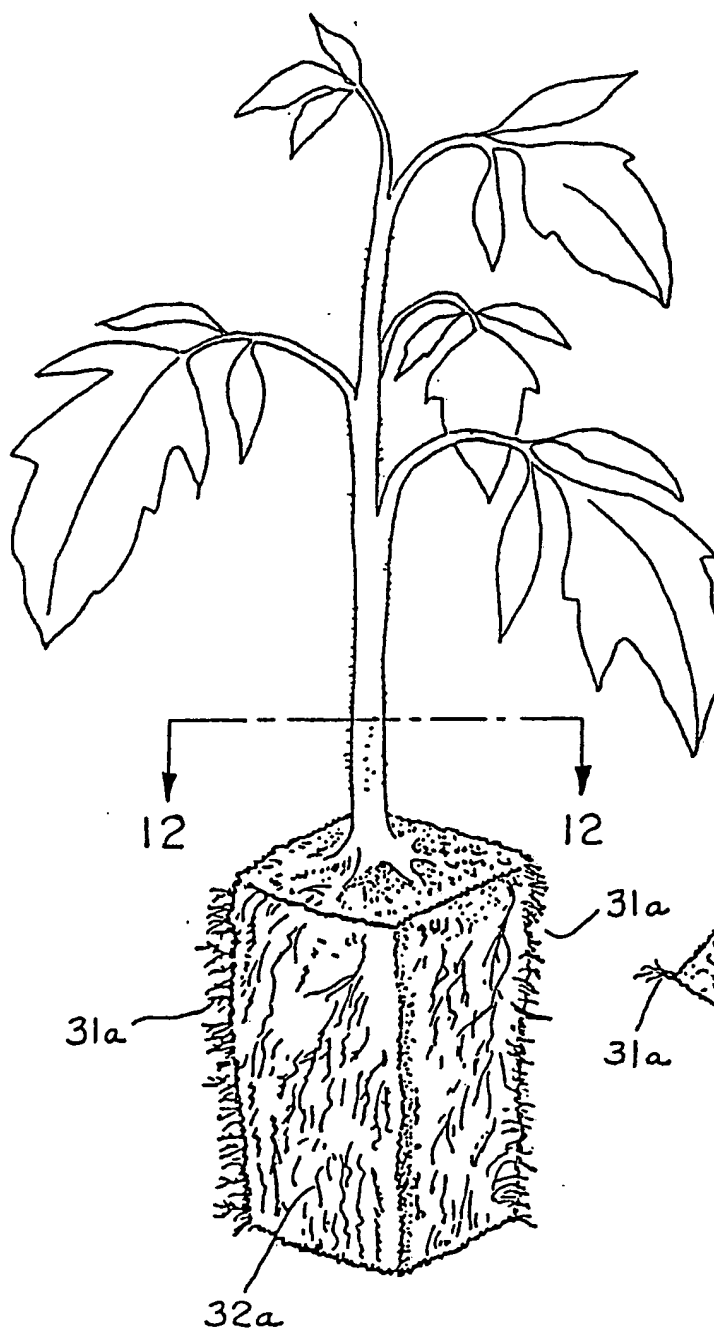


FIG. II

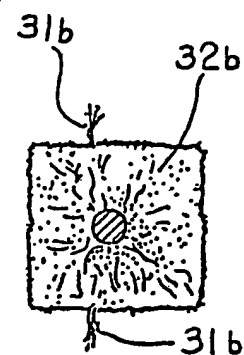


FIG. 12A

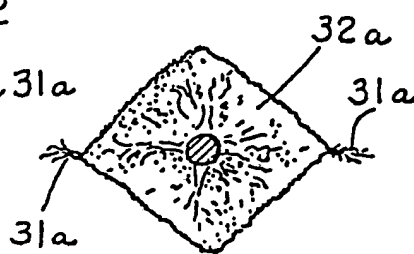


FIG. 12



# INTERNATIONAL SEARCH REPORT

International Application No PCT/US87/03011

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>2</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC (4): A01B 79/00; A01G 9/10		
U.S. Cl. 47/58		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>4</sup>		
Classification System	Classification Symbols	
U.S.---	47/1A, 58, 66, 73, 74, 77, 85, 86, 87; 111/2, 3	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>6</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup>		
Category <sup>8</sup>	Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>
Y	US, A, 4,248,014 (WILLIAMES) 03 February 1981, see the entire document.	4-7, 13-15, 21
Y	US, A, 3,515,036 (OKI ET AL) 02 June 1970 See the entire document.	4-7, 11, 13-15, 21
Y	US, A, 3,825,126 (POHL ET AL) 23 July 1974 See the entire document.	4-7, 13-15, 21
Y	US, A, 4,213,274 (SKAIFE) 22 July 1980 See the entire document.	8-10
Y	DE, A, 3,238,594 (BRAUN) 19 April 1984 See the entire document.	1-3, 16
X	US, A, 4,434,576 (SOWERWINE) 06 March 1984 See the entire document.	17
Y	US, A, 3,432,027 (MUELLER) 11 March 1969 See the entire document.	12
Y	US, A, 4,411,205 (ROGERS) 25 October 1983 See the entire document.	1-3
<p><sup>8</sup> Special categories of cited documents: <sup>15</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search <sup>1</sup>	Date of Mailing of this International Search Report <sup>3</sup>	
11 March 1988	29 MAR 1988	
International Searching Authority <sup>1</sup>	Signature of Authorized Officer <sup>10</sup>	
ISA/US	D. DeMille	

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